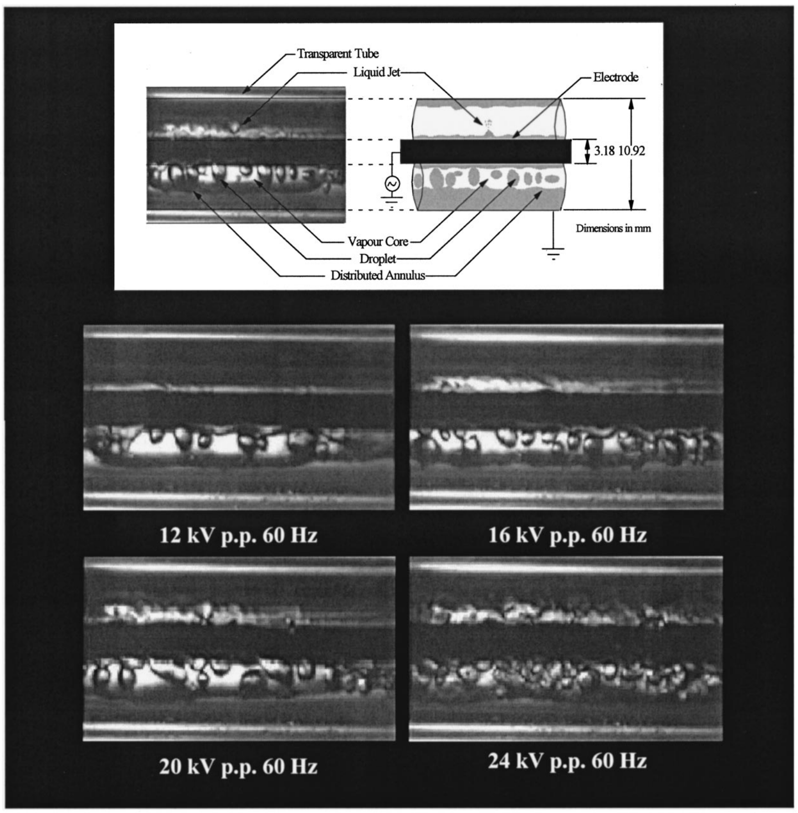

Fig. 1 High speed video images of oscillatory entrained droplet EHD two-phase flow

OSCILLATORY ENTRAINED DROPLET EHD TWO-PHASE FLOW

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In an experimental investigation of electrohydrodynamic two-phase flow, the application of a 60 Hz AC voltage potential to convective boiling and condensation systems has led to a regime unique to any flow pattern previously observed [1–3]. It is an oscillatory flow, where droplets as large as 2 mm in diameter are entrained in a vapor core that is surrounded by an annular liquid film around the circumference of the tube and electrode, resembling a multi-layered annular flow. The droplets oscillate radially in the lower portion of the annulus at a frequency of approximately 120 Hz, twice the frequency of the applied field, occasionally being entrained by the inner or outer annular film. In addition to the droplet formation, small spouts or jets of liquid were observed on the upper half of the annular film surrounding the electrode. These spouts seemed to form randomly on the crest of a wave created by interfacial instabilities present in the film and would spray a fine mist into the upper portion of the vapor core, as shown in the upper figure. The size of the droplets, intensity of motion, rate of deposition and the occurrence of spouts were highly dependent on the amplitude of the 60 Hz applied voltage.

The interaction between the phases and the extremely high interfacial area, when coupled with the increased turbulent mixing created by the oscillatory motion of the flow, led to significant enhancement of the overall Nusselt number (~300 percent) and overall pressure drop in both condensation and evaporation when applied under the appropriate conditions [1–3]. The frequency of the oscillations suggests that the fluctuations in the flow pattern are actually the continuous transition between flow regimes due to the approximate ''on/off'' electric field applied to the electrode. It is postulated that the resultant flow regime is the continuous construction and destruction of two separate flow regimes. For example, at Re=3500 the flow pattern in the absence of the electric field is dominantly stratified flow and intermittent annular or entrained droplet flow at high applied DC voltage levels [1,4]. Hence, the oscillatory-entrained droplet flow pattern is believed to be a result of the continuous flow pattern transition between these two regimes (Fig. 1).

References

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